

**PALEARCTIC SYMPIESIS ACALLE AND SYMPIESIS GORDIUS
(HYMENOPTERA: EULOPHIDAE) IN NORTH AMERICA: TAXONOMIC
CHANGES AND A REVIEW OF NEARCTIC HOST RECORDS**

CHRIS T. MAIER AND CHRISTER HANSSON

(CTM) Department of Entomology, Connecticut Agricultural Experiment Station, P.O. Box 1106, New Haven, CT 06504, U.S.A. (e-mail: Chris.Maier@po.state.ct.us); (CH) Department of COB, Zoology, Helgonavägen 3, SE-223 62 Lund, Sweden (e-mail: Christer.Hansson@cob.lu.se)

Abstract.—The Palearctic eulophids, *Sympiesis acalle* (Walker) and *S. gordius* (Walker), are widespread in North America where they have been known as *S. bimaculatipennis* Girault and *S. marylandensis* Girault, respectively. To update their taxonomy, we have established seven **new synonyms**: *Astichus bimaculatipennis* Girault, *Sympiesis bimaculata* Crawford, and *S. meteori* Girault = *S. acalle* (Walker); and, *S. marylandensis* Girault, *S. rex* Girault, *S. miltoni* Girault, and *S. lexingtonensis* Girault = *S. gordius* (Walker). We also have designated six lectotypes: *Eulophus acalle* Walker, *E. gordius* Walker, *E. alparus* Walker, *E. pisenor* Walker, *Sympiesis rex* Girault, and *S. lexingtonensis* Girault. Finally, we summarize the North American host records of *Sympiesis acalle* and *S. gordius*, which frequently are cited as biocontrol agents of pestiferous leafminers.

Key Words: Eulophidae, hosts, leafminer, *Phyllonorycter*, *Sympiesis bimaculatipennis*, *Sympiesis marylandensis*

Many eulophid wasps (Chalcidoidea: Eulophidae) have a large distribution, with some species occurring on two or more continents (Noyes 2002). Numerous species occur in both Europe and North America (e.g., Hansson 1987), a fact often overlooked because certain species have a different name in Europe and North America. Such nomenclatural mistakes make it difficult to understand fully the natural history of a species and even might interfere with biocontrol efforts. Here we reveal two additional cases of mistaken identity, both in the genus *Sympiesis* Förster. In the process, we establish seven new synonyms and designate six lectotypes.

Bellostas et al. (1998) have published color photographs of parasitoids of European leafminers, *Phyllonorycter* spp. (Lep-

idoptera: Gracillariidae), of cultivated apple, *Malus domestica* Borkhausen. Among their images were two eulophid species, *Sympiesis acalle* (Walker) and *S. gordius* (Walker) that appeared remarkably similar to the North American species, *S. bimaculatipennis* (Girault) and *S. marylandensis* Girault, respectively. In North America, Miller (1970), Maier (1988a, b), and others have recorded hosts of these two parasitoids to be species of *Phyllonorycter* and other Lepidoptera whose larvae live in mines and other concealed situations. In Canada and the United States, *S. marylandensis* is an important natural enemy of leafminers, especially the apple pests, *Phyllonorycter blancardella* (Fabricius), *P. crataegella* (Clemens), and *P. mespilella* (Hübner) (e.g., Maier 1994, 2002). In this paper, we

note the synonymy and summarize the North American records of hosts of the two *Sympiesis* spp. This information hopefully will assist economic entomologists in recognizing that the biocontrol previously attributed to two "native" species is, in fact, caused by two European species, or possibly holarctic species, that have long been associated with apple leafminers in European orchards.

LECTOTYPE DESIGNATIONS AND NEW SYNONYMS

Type specimens discussed below are deposited in the following museums: BMNH, The Natural History Museum, London, England; INHS, Illinois Natural History Survey, Champaign, IL, USA; USNM, Smithsonian Institution, National Museum of Natural History, Washington, DC, USA.

Sympiesis acalle (Walker)

Eulophus acalle Walker 1848: 234. Lectotype male (**new designation**) in BMNH, examined.

Entedon nubeculatus Ratzeburg 1848: 158. Synonymized by Bouček (1959).

Eulophus bifasciatus Thomson 1878: 230. Synonymized by Bouček (1959).

Eulophus punctifrons Thomson 1878: 231. Synonymized by Bouček (1959).

Astichus bimaculatipennis Girault 1912: 8. Holotype female in INHS, examined. **New synonymy.**

Sympiesis bimaculata Crawford 1913: 259. Holotype female in USNM, examined. **New synonymy.**

Sympiesis meteori Girault 1916: 37. Holotype female in USNM, examined. **New synonymy.**

Sympiesis acalle: Graham 1959: 182.

A single male with the name "*Eulophus acalle*" is in the collection at BMNH (with the label "*Eulophus acalle* Walker" and our lectotype label). The gaster has been gnawed on left side, but otherwise the specimen is intact. The original description was based on one or more male specimens. The

single remaining specimen agrees with the original description. Walker (1848) did not indicate on how many specimens his description was based; therefore, to keep the nomenclature stable, the name hereby is fixed to the male specimen which is here designated the lectotype.

The female holotypes of *A. bimaculatipennis*, *S. bimaculata*, and *S. meteori* agree well with our interpretation of *S. acalle* (i.e., with females linked to males that are conspecific with the lectotype male of *S. acalle*); and, *S. acalle*, *S. bimaculatipennis*, *S. bimaculata*, and *S. meteori* undoubtedly belong to the same species. The holotype of *A. bimaculatipennis* has the mesosoma, including only front left leg, glued to a point (type no. 45.012); the head (squashed) and the antennae are on a slide (type no. 45.013); wings, most of the legs, and the gaster are missing. The holotype of *S. bimaculata* is glued to a point (type no. 15094); the entire left antenna, right antenna beyond the scape, and right wing pair are missing. The holotype of *S. meteori* is glued to a point (type no. 19995) and is broken in two parts, gaster and mesosoma; the head, pair of right wings and left hind wing, right fore tarsus, right mid tibia and tarsus, and left and right hind tibiae and tarsi are missing.

Sympiesis gordius (Walker)

Eulophus gordius Walker 1839: 129. Lectotype male (**new designation**) in BMNH, examined.

Eulophus alaparus Walker 1839: 163. Lectotype female (**new designation**) in BMNH, examined. Synonymized by Bouček (1959).

Eulophus pisenor Walker 1839: 153. Lectotype male (**new designation**) in BMNH, examined. Synonymized by Bouček and Askew (1968).

Eulophus cervicornis Förster 1841: 43. Synonymized by Bouček (1959).

Entedon padellae Ratzeburg 1844: 166. Synonymized by Bouček (1959).

Eulophus bulmerincqii Ratzeburg 1848:

155. Synonymized by Bouček and Askew (1968).

Eulophus laevisimus Ratzeburg 1848: 157. Synonymized by Bouček (1959).

Eulophus stramineipes Thomson 1878: 232. Synonymized by Bouček (1959).

Sympiesis rex Girault 1917a: 2–3. Lectotype female (**new designation**) in USNM, examined. **New synonymy.**

Sympiesis miltoni Girault 1917b: 7. Lectotype female, designated by Miller (1970), in USNM, examined. **New synonymy.**

Sympiesis marylandensis Girault 1917c: 37. Holotype female in USNM, examined. **New synonymy.**

Sympiesis lexingtonensis Girault 1917d: 6. Lectotype female (**new designation**) in USNM, examined. **New synonymy.**

Eulophus albiscapus Erdős 1954: 327. Synonymized by Bouček (1959).

Sympiesis gordius: Graham 1959: 183.

Single specimens under the names “*Eulophus gordius*” (a male), “*Eulophus alaparus*” (a female), and “*Eulophus pisenor*” (a male) are in the collection at BMNH. Walker’s (1839) descriptions of these three species were based on an unknown number of specimens. Therefore, to stabilize the nomenclature, we chose these three specimens as the lectotypes for each species. The specimens are labelled “*Eulophus gordius* Walker,” “*Eulophus alaparus* Walker,” and “*Eulophus pisenor* Walker”; each also has our lectotype label.

A single specimen under the name *Sympiesis rex* is in the collection at USNM. Girault (1917a) did not indicate on how many specimens he based his description. Therefore, to stabilize the nomenclature, we chose this specimen as the lectotype for *S. rex*. The specimen carries the labels “Quaintance No. 11468,” “Salem, Ore, vi.15,” “Reared *Phyllonorycter crataegella*,” “E. J. Newcomer collector,” “20218,” “*Sympiesis rex* Girault female type,” and our lectotype label.

A single specimen stands under the name *Sympiesis lexingtonensis* in the collection at

USNM. Girault (1917d) did not indicate on how many specimens he based his description. Therefore, to stabilize the nomenclature, we chose this specimen as the lectotype for *S. lexingtonensis*. The specimen carries the labels “1866,” “20196,” “*Sympiesis lexingtonensis* Gir. female type,” and our lectotype label.

The female holotype of *S. marylandensis*, and the lectotypes of *S. rex*, *S. miltoni*, and *S. lexingtonensis* agree well with our interpretation of *S. gordius* (i.e., with females linked to males that are conspecific with the lectotype male of *S. gordius*); and, *S. gordius*, *S. rex*, *S. miltoni*, *S. marylandensis*, and *S. lexingtonensis* undoubtedly belong to the same species. The lectotype of *S. rex* is glued to a point (type no. 20218); the head and right wing pair are missing. The lectotype of *S. miltoni* is glued to a point (type no. 21399), and the type is intact. The holotype of *S. marylandensis* is glued to a point (type no. 20137); the head is missing (according to the original description the head is on a slide, not examined by us). The lectotype of *S. lexingtonensis* is glued to a point (type no. 20196); the head, right legs (all three), and pair of right wings are missing.

BIOLOGY

Hosts of both *S. acalle* and *S. gordius* that were discovered during original North American studies (Table 1) are repeated in the catalogs of Peck (1951, 1963) and Burks (1979) and, to some extent, in the revision of Miller (1970). Green (1979) and Maier (1988b) have since reported many new North American hosts. *Sympiesis acalle*, previously known as *S. bimaculatipennis* in North America, is both a primary and secondary ectoparasitoid of lepidopteran larvae and pupae (Table 1) that usually live in concealed places, such as blotch mines or rolled leaves. *Sympiesis acalle* has at least 15 hosts in North America. It is a primary parasitoid of Tischeriidae (1 species), Gracillariidae (5), Oecophoridae (1), and Tortricidae (6). In addition, it parasitizes the

Table 1. Hosts of *Sympiesis acalle* and *S. gordius* that were recorded as *S. bimaculatipennis* and *S. marylandensis*, respectively, in the North American literature. Due to taxonomic revisions or changes in generic use and species concepts, some of the hosts cannot be placed in a genus and are excluded here. Hosts given only to genus are followed by the genus of their host plant in brackets; if these hosts could be one of the fully identified hosts, they are not included in the total number of hosts given in the text. Generic records without an associated host plant are excluded from the main part of the table. To the best of our knowledge, all of the scientific names are the ones currently in use.

Order, Family, and Species of Host	<i>S. acalle</i>	<i>S. gordius</i>	Literature Sources
LEPIDOPTERA			
Nepticulidae			
<i>Nepticula variella</i> (Braun)		X	Green (1979)
Tischeriidae			
<i>Tischeria malifoliella</i> Clemens ^a	X	X	Dunnam (1924), Peck (1951, 1963), Miller (1970), Burks (1979), Oatman (1985)
<i>Tischeria</i> sp. [<i>Solidago</i>]		X	Maier (1994, unpublished data)
Heliozelidae			
<i>Coptodisca powellella</i> Opler		X	Green (1979)
Lyonetidae			
<i>Bacculatrix albertiella</i> Busck		X	Green (1979)
Gracillariidae			
<i>Caloptilia agrifoliella</i> Opler		X	Green (1979)
<i>Caloptilia</i> sp. [<i>Betula</i>] ^b		X	Miller (1970), Burks (1979)
<i>Cameraria agrifoliella</i> (Braun)		X	Green (1979)
<i>C. caryaefoliella</i> (Clemens)		X	Heyerdahl and Dutcher (1985)
<i>C. wislizeniella</i> Opler		X	Green (1979)
<i>Cameraria</i> spp. [<i>Ostrya</i>]		X	Maier (1988b)
<i>Cremastobombycia solidaginis</i> (Frey and Boll)		X	Maier (1988b)
<i>Neurobathra bohartiella</i> (Opler)		X	Green (1979)
<i>Parectopa robiniella</i> Clemens		X	Weaver and Dorsey (1965)
<i>Parornix geminatella</i> (Packard) ^c	X	X	Haseman (1916), Girault (1916), Copenhafer and Parker (1938), Peck (1951, 1963), Miller (1970), Burks (1979), Oatman (1985), Maier (1988b)
<i>Parornix</i> sp. [<i>Betula</i>]		X	Maier (1988b)
<i>Parornix</i> sp. [<i>Lyonia</i>]		X	Maier (1988b)
<i>Phyllocnistis populiella</i> Chambers		X	Miller (1970), Burks (1979)
<i>Phyllonorycter aeriferella</i> (Clemens)		X	Maier (1988b)
<i>P. albanotella</i> (Chambers)		X	Maier (1988b)
<i>P. argentifrimbriella</i> (Clemens)		X	Maier (1988b)
<i>P. argentintotella</i> (Clemens)		X	Maier (1988b)
<i>P. antiochella</i> (Opler)		X	Green (1979)
<i>P. auronitens</i> (Frey and Boll)		X	Maier (1988b)
<i>P. basistrigella</i> (Clemens)		X	Miller (1970), Burks (1979), Maier (1988b)
<i>P. blancardella</i> (Fabricius)	X	X	Miller (1970), Pottinger and LeRoux (1971), Johnson et al. (1976), Dutcher and Howitt (1978), Burks (1979), Weires et al. (1980), Van Driesche and Taub (1983), Maier (1984, 1988b, 1992, 1993, 1994, 2002), Hagley (1985), Ridgway and Mahr (1985, 1989, 1990), Biggs and Hagley (1988), Hagley and Barber (1991), Gagné and Barrett (1994), Bishop et al. (2001)
<i>P. caryaealbella</i> (Chambers)		X	Heyerdahl and Dutcher (1985)

Table 1. Continued.

Order, Family, and Species of Host	<i>S. acalle</i>	<i>S. gordius</i>	Literature Sources
<i>P. celtisella</i> (Chambers)		X	Miller (1970), Burks (1979)
<i>P. crataegella</i> (Clemens)	X	X	Beckham et al. (1950), Peck (1951, 1963), Parent (1962), Miller (1970), Burks (1979), Weires et al. (1980), Maier (1982, 1988b, 1992, 1993, 1994), Gambino and Sullivan (1982), Van Driesche (1983), Van Driesche and Taub (1983), Drummond et al. (1985), Oatman (1985), Van Driesche et al. (1985), Gagné and Barrett (1994), Maier and Weseloh (1995)
<i>P. emberizaepenella</i> (Bouché)		X	Maier (1988b)
<i>P. felinelle</i> Heinrich		X	Miller (1970), Burks (1979)
<i>P. fitchella</i> (Clemens)		X	Maier (1988b)
<i>P. inusitatella</i> (Braun)		X	Green (1979)
<i>P. kearfottella</i> (Braun)		X	Maier (1988b)
<i>P. lucetiella</i> (Clemens)		X	Maier (1988b)
<i>P. lucidicostella</i> (Clemens) ^d		X	Miller (1970), Burks (1979), Maier (1988b)
<i>P. mespilella</i> (Hübner)	X	X	Doğanlar and Beirne (1980), Barrett and Jorgensen (1986), Varela and Welter (1992), Cossentine and Jensen (1994), McGregor (1996)
<i>P. morrisella</i> (Fitch)		X	Maier (1988b)
<i>P. obscuricostella</i> (Clemens)		X	Maier (1988b)
<i>P. propinquinella</i> (Braun)		X	Miller (1970), Burks (1979), Maier (1988a, b, 1994)
<i>P. restrictella</i> (Braun)		X	Maier (1988b)
<i>P. robiniella</i> (Clemens)		X	Weaver and Dorsey (1965), Miller (1970), Burks (1979), Maier (1988b)
<i>P. salicifoliella</i> (Chambers) ^{e,f}		X	Miller (1970), Burks (1979), Maier (1988b)
<i>P. sandraella</i> (Opler)		X	Green (1979)
<i>P. scudderella</i> (Frey and Boll)		X	Maier (1988b)
<i>P. tremuloidiella</i> (Braun)		X	Maier (1988b)
<i>P. trinotella</i> (Braun) ^f		X	Maier (1988b)
<i>P. tritaenianella</i> (Chambers)		X	Maier (1988b)
<i>Phyllonorycter</i> sp. near <i>crataegella</i> (Clemens)	X	X	Maier (1988a, b, 1994)
<i>Phyllonorycter</i> sp. [<i>Alnus</i>]		X	Miller (1970)
<i>Phyllonorycter</i> sp. [<i>Amphicarpa</i>]		X	Miller (1970)
<i>Phyllonorycter</i> sp. [<i>Fagus</i>] ^f		X	Miller (1970)
<i>Phyllonorycter</i> sp. [<i>Lonicera</i>]		X	Miller (1970)
<i>Phyllonorycter</i> sp. [<i>Malus</i>] ^g		X	Girault (1917a), Peck (1951, 1963), Newcomber (1958), Miller (1970)
<i>Phyllonorycter</i> sp. [<i>Populus</i>]		X	Miller (1970)
<i>Phyllonorycter</i> sp. [<i>Prunus</i>]		X	Miller (1970)
<i>Phyllonorycter</i> sp. [<i>Tilia</i>]		X	Miller (1970)
Oecophoridae			
<i>Agonopteryx posticella</i> (Wal-singham)	X		Miller (1970), Burks (1979)
Cosmopterygidae			
<i>Stilbosis dulcedo</i> (Hodges)		X	Green (1979)
Gelechiidae			
<i>Coleotechnites thujaella</i> (Kearfott)		X	Miller (1970), Burks (1979)
Tortricidae			
<i>Acleris chalybeana</i> (Fernald)		X	Miller (1970), Burks (1979)

Table 1. Continued.

Order, Family, and Species of Host	<i>S. acalle</i>	<i>S. gordius</i>	Literature Sources
<i>Ancylis comptana</i> (Frölich)	X		Miller (1970), Burks (1979)
<i>Choristoneura rosaceana</i> (Harris)	X		Schuh and Mote (1948), Peck (1963)
<i>Epinotia laraana</i> (Kearfott)	X		Miller (1970)
<i>Rhopobota naevana</i> (Hübner)	X		Fitzpatrick et al. (1994)
<i>Spilonota laricana</i> (Heinemann)	X		Burks (1979)
<i>Spilonota ocellana</i> (Denis and Schiffermüller)	X		Sadava and Miller (1967), Miller (1970), Burks (1979)
HYMENOPTERA			
Tenthredinidae			
<i>Heterarthrus nemoratus</i> (Fallén)		X	Miller (1970), Burks (1970)
Braconidae ^b			
<i>Pholetesor ornigis</i> (Weed) ^c	X		Pottinger and LeRoux (1971), Maier (1982, 1984), Bishop et al. (2001)
Chalcididae			
<i>Spilochalcis</i> sp. ^d	X		Bishop et al. (2001)

^a Dunnam's (1924) record apparently is repeated by Peck (1951, 1963), Miller (1970), and Burks (1979).

^b Both Miller (1970) and Burks (1979) gave the *Caloptila* host as *C. elongella* (Linnaeus), but this species is not known to occur in North America.

^c Haseman's (1916) study provided the record of *S. acalle* given in Girault (1916) and Peck (1951, 1963), and Copenhagen and Parker's (1938) record apparently also was repeated for one of the junior synonyms of *S. acalle* in Peck (1963); the record in Burks (1979) probably was repeated from an earlier catalog.

^d Girault (1917d) listed a host as a blotch miner on maple, which may have been a *Phyllonorycter* sp. or possibly a *Cameraria* sp.

^e This species on *Populus* sp. mentioned in Miller (1970) and probably repeated by Burks (1979) is more likely to be *Phyllonorycter tremuloidiella* (Braun) or another *Phyllonorycter* sp. on *Populus*; *P. salicifoliella* is a willow-feeder.

^f Procter (1938, 1946) mentioned *S. gordius* as a parasite of blotch miners on *Fagus* (probably *Phyllonorycter restrictella*) and *Salix* (probably *Phyllonorycter scudderella* or *P. salicifoliella*), and the record of the blotch miner on *Fagus* is repeated in Peck (1951, 1963); the record of the blotch miner on *Fagus* is duplicated in Peck (1951, 1963) and Miller (1970).

^g Newcomer (1958) did not report his record from an apple-feeding *Phyllonorycter* sp. (misidentified as *P. crataegella*) until 1958; this record is the one mentioned in Girault (1917a).

^h Webster (1909) retrieved *S. acalle* from an insectary and reported that it parasitized an unidentified internal primary parasitoid of the tortricid moth, *Acleris minuta* (Robinson), a record that was repeated, sometimes in altered form, by Girault (1912), Frison (1927), Peck (1951, 1963), and Burks (1979).

ⁱ Primary hosts of *S. acalle* on *Pholetesor ornigis* were *Phyllonorycter blancardella* and *P. crataegella*; that from *Spilochalcis* sp. was *P. blancardella*.

braconid *Pholetesor ornigis* (Weed) and the chalcid *Spilochalcis* sp., which both attack apple leafminers, *Phyllonorycter* spp. The casual rearing methods used in some studies (e.g., Oatman 1985) may have resulted in overlooking hyperparasitic associations or in identifying the wrong primary host. In northeastern North America, *S. acalle* is a facultative hyperparasitoid of the gracillariid leafminers *Phyllonorycter blancardella* and *P. crataegella*, attacking especially their braconid parasitoid, *Pholetesor ornigis* (e.g., Maier 1982, 1984).

Under the name of *S. marylandensis* in the North American literature, *S. gordius* is known to be a primary ectoparasitoid of larvae and sometimes pupae of miners, skeltonizers, and rollers of leaves, and of other insects (Table 1) that live in sheltered situations. Most of the original host records are from Miller (1970), Green (1979), and Maier (1988b). In North America, *S. gordius* parasitizes at least 53 species in the families Nepticulidae (1), Tischeriidae (2), Heliozelidae (1), Lyonetidae (1), Gracillariidae (44), Cosmopterygidae (1), Gelechi-

idae (1), Tortricidae (1), and Tenthredinidae (1). Maier (1988b) has concluded that in the northeastern United States *S. gordius* prefers gracillariid larvae inhabiting mines on the underside of leaves. Some of the western host records may refer to parasitization by *S. yuekseli* Doğanlar (1979), which is similar to *S. gordius* and was described after some of the records in Table 1 were published. Based on host records given by Bouček and Askew (1968), Storozheva (1982), and others, both *S. acalle* and *S. gordius* have similar hosts in the Palearctic and Nearctic regions. Delucchi (1958), Bouček and Askew (1968), Storozheva (1982), and others have reported that *S. gordius* sometimes is a secondary parasitoid of braconids and eulophids, but this type of association is not yet known in North America.

Both *S. acalle* and *S. gordius* are mentioned in the biocontrol literature about gracillariids in apple orchards in Europe (e.g., Baggiolini 1960, Casas and Baumgartner 1990, Bellostas et al. 1998) and in North America (Maier 1994, 2002, and references therein). Especially *S. gordius* has been touted as an important natural enemy of the pestiferous apple leafminers, *Phyllonorycter blancardella*, *P. crataegella*, and *P. mespilella* (see references in Table 1). Maier (1984, 1992) and Gagné and Barrett (1994) have examined the seasonal flight activity of *S. gordius*; Maier (1992) suggested that it could have six or seven generations per year while its host *P. crataegella* has only three. Also, Maier and Welsh (1995) have shown that *S. gordius* tended to have higher abundance near the edge than the center of apple orchards.

We consider it to be highly likely that the two European eulophids were introduced accidentally into North America with one or both of their European hosts, *P. blancardella* and *P. mespilella*, which are leafminers of non-native apple. The European facultative hyperparasitoid, *S. sericeicornis* (Nees), which for many years masqueraded under the junior synonym *S. conica* (Provancher), probably had a similar route of

entry into North America. Although it is less likely, these *Sympiesis* spp., known so long by their junior synonyms in North America, actually could be Holarctic or could have spread from North America to Europe. Comparative studies of genetic diversity of populations in Europe and North America might clarify the continent(s) of origin of these *Sympiesis* spp.

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